The Returns to Higher Education for Marginal Students: Evidence from Colorado Welfare Recipients *

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Abstract

I estimate the impact of community college credits and credentials on the labor market outcomes of several cohorts of current and former welfare recipients. Using an individual fixed effects approach, I find that women who attend college after entering welfare experience large and significant earnings gains. These returns are driven by credential receipt and when sub-associate's degree credentials are unobservable, positive earnings gains will be inappropriately attributed to college attendance alone.

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1 Introduction

Public two-year colleges serve an increasingly important role in meeting the growing demand for an educated workforce in the United States. Students induced to enroll in college by changes in the costs or returns to higher education are more likely to attend a two-year institution and these schools have absorbed much of the growth in college attendance over the past several decades (Bound, Lovenheim and Turner 2010). In January 2015, President Obama released a proposal to further expand access to community college programs by making the first two years of enrollment free for all students.[1] Although numerous studies provide evidence of substantial labor market returns to community college credits and credentials (Belfield and Bailey 2011), it is unclear whether individuals at different parts of the skill distribution would experience equally large returns from attending a two-year institution.[2]

In this paper, I focus on a group of students who are particularly constrained in their ability to finance college attendance – mothers who are current and former welfare recipients. Mothers at risk for welfare receipt are an especially relevant group given their generally low levels of income, education, and the time limits on welfare eligibility.[3] Furthermore, over the past two decades, federal policy has placed increasing restrictions on welfare recipients' ability to attend college while receiving cash assistance, with corresponding decreases in postsecondary enrollment (Dave et al. 2011; Dave, Corman and Reichman 2012).

I estimate the impact of community college attendance, credits, and credential receipt on the labor market outcomes of several cohorts of Colorado welfare entrants. My preferred specification controls for an extensive set of time-varying observable characteristics (e.g., number and age of children, vehicle ownership), as well as unobservable individual-specific characteristics that are time-invariant or vary linearly over time. Women who enroll in college following welfare entry experience large and significant earnings gains. These gains are entirely driven by credential receipt. All career-oriented community college credentials - from short-term certificates that require as few as 15 credits to associate degrees - lead to significant earnings gains. Conversely, associate of arts and general studies degrees, while potentially facilitating transfer to a four-year degree program, lead to only small and largely insignificant changes in earnings.[4]

My identification strategy closely follows that of Jacobson, LaLonde and Sullivan (2005). I take advantage

[1] See https://www.whitehouse.gov/the-press-office/2015/01/09/fact-sheet-white-house-unveils-america-s-college-promise-proposal-tuitio for additional details.

[2] Several studies find evidence that academically marginal students benefit from admission to a four-year institution (e.g., Zimmerman 2014; Goodman, Hurwitz and Smith 2015) and Backes, Holzer and Velez (2015) show that community college attendance increases earnings among disadvantaged youth, but there is little evidence of whether marginal nontraditional students benefit from attending a two-year institution.

[3] Federal law limits recipients to 60 lifetime months of cash assistance receipt, while many states have shorter time limits (Ziliak forthcoming).

[4] Using data on transfer students from a single state, Crosta and Kopko (2014) find among students with at least 50 community college credits, those who earn associate of arts degrees are more likely to transfer to a four-year institution and subsequently receive a bachelor's degree than students who did not earn a degree or applied science degree recipients.

of the fact that my data contains information on individuals' labor market outcomes before and following community college attendance. Under the identifying assumption that, conditional on time-varying observable characteristics, trends in an individual's pre-college labor market outcomes represent a valid counterfactual for the evolution of their earnings and employment in the absence of college attendance, my estimates will represent the causal impact of community college credits and credentials. Consistent with prior findings (e.g., Jepsen, Troske and Coomes 2014; Backes, Holzer and Velez 2015; Bahr et al. 2015; Liu et al. 2015; Stevens, Kurlaender and Grosz 2015; Dadgar and Trimble forthcoming), women who earn credentials in health, science, or technical fields experience the largest labor market benefits. However, in contrast with studies that find little to no average impact of short-term credentials on the average community college student's earnings (e.g., Jepsen, Troske and Coomes 2014; Bahr et al. 2015; Liu et al. 2015; Dadgar and Trimble forthcoming), I estimate that even women who earn short-term certificates in non-technical fields experience statistically significant earnings gains.

Furthermore, I document that failure to account for sub-associate credentials results in falsely attributing positive earnings gains to college attendance in the absence of credential receipt in my setting. Measures of educational attainment in most major surveys, such as the Decennial Census, Current Population Survey, and American Community Survey, do not include certificate receipt, suggesting the large category generally classified as "some college" includes a heterogeneous group of individuals.[5] Given the low completion rates of community college students, it is especially important to distinguish between earnings gains due to credit completion and those driven by credential receipt.

Finally, I use information on post-college earnings trajectories, direct and indirect costs associated with college attendance, and public assistance receipt to approximate short- and medium-run private returns to college attendance. When foregone earnings and direct postsecondary costs are taken into consideration, short-run private rates of return to certificates and most degrees are negative, providing a rationale as to why so few women complete credentials, even in light of the large impacts on post-college earnings.

My findings speak to the question of whether state and federal welfare policy should support formal human capital development and suggest that supports for credential completion are just as, if not more, important than funding targeted towards increasing college attendance. Furthermore, my results have implications beyond welfare policy given the increases in community college enrollment that would occur without tuition. If students induced to enroll in community college due to these efforts are more disadvantaged than the average community college student, my results can also inform future policies targeting such groups.

The remainder of this chapter proceeds as follows: in Section 2, I discuss the evolution of federal welfare policy towards human capital development as well as research findings on the returns to the two-year sector

[5]For instance, the 2009 American Community Survey places 21 percent of adults in this category (Snyder and Siebens 2012).

of higher education. Section 3 discusses my data and presents descriptive results, while Section 4 describes my empirical approach. In Section 5, I present estimates of the impact of community college credits and credentials on labor market outcomes. Section 6 discusses my estimates of the private returns to community college over the short- and medium-run and 7 concludes.

2 Welfare Policy and Human Capital Development

Over the past two decades, federal welfare policy has become increasingly less supportive of concurrent college enrollment and cash assistance receipt. Welfare recipients are eligible for Pell and federal loan aid and under the pre-1996 Aid to Families with Dependent Children (AFDC) program, recipients' ability to attend college while receiving welfare was relatively unconstrained.[6] Attending a post-secondary institution while on welfare was not uncommon – one study estimates that 14 percent of all recipients attended college while receiving AFDC benefits (London 2006).

The 1996 Personal Responsibility and Work Reconciliation Act (PRWORA) made it more difficult to receive welfare while attending college. The legislation imposed work requirements and time limits on welfare recipients, increasing the costs associated with postsecondary education by requiring part-time employment or exit from welfare for those wishing to attend college full-time. Although states had the option to exempt welfare recipients enrolled in college from work requirements in their first two years of receipt, the policy change led to a significant reduction in college enrollment for single mothers. Nationwide, the representation of welfare recipients among women enrolled in college also fell over this period. While 11 percent of all female students classified as independent received cash assistance during the 1995-96 academic year, only 2 percent of students in this group received welfare in 2000.[7] Using a differences-in-differences-in-differences identification strategy that compares changes in college-going of women at risk for welfare receipt relative to other women across states and over time, Dave, Corman and Reichman (2012) estimate that PRWORA led to a 20 percent decrease in college enrollment. Dave et al. (2011) find effects of a similar magnitude on enrollment in full-time vocational education programs.

The 2005 Deficit Reduction Act (DRA) further decreased welfare recipients' ability to attend college by increasing pressure on states to place welfare recipients in "employment-related activities". PRWORA required states to have at least 50 percent of single parents participating in a specific set of work activities, including paid employment, workfare/community service, and education/training. Before DRA, states could deduct each percentage point of caseload reduction since 1995 from their work participation rate target. Since

[6] Single parents who received public assistance in the prior year automatically qualify for an "automatic zero expected family contribution" and the maximum Pell Grant.

[7] Author's calculations using the 1996 and 2000 National Postsecondary Student Aid Study samples via PowerStats.

caseloads declined steeply following PRWORA, this requirement was not binding for most states, including Colorado. DRA reset the base year to 2005 and imposed additional limitations on welfare recipients to count higher education towards their participation requirements. Specifically, recipients were further limited to a total of 12 lifetime months of education that must be combined with another, employment-related activity, essentially limiting individuals to, at most, one year of part-time college attendance while receiving welfare.

Between 1999 and 2012, the share of welfare recipients engaged in education and training activities ranged from 4 to 7 percent of the national population (Figure 1, Panel A). A larger share of Colorado welfare recipients were engaged in education-related activities over this period (Figure 1, Panel B). Concurrent college attendance and cash assistance receipt fell by over 20 percent after DRA passed even as total female enrollment in Colorado's community colleges increased 9 percent over this period.[8]

Whether low-skill parents at risk for welfare receipt benefit from higher education is an open question. The majority of studies that explicitly focus on welfare recipients compare the impact of education relative to "work first" activities (e.g., job search assistance) on earnings and welfare recipient. Early evaluations found little evidence that recipients benefited from education and human capital development activities (e.g., findings from California's GAIN experiment discussed in Riccio and Friedlander (1992) and Riccio, Friedlander and Freedman (1994)). Later research illustrated the possibility that earnings increases following education might take longer to appear. For instance, Hotz, Imbens and Klerman (2006) show that California welfare recipients assigned to education-focused activities experienced larger earnings gains over the long-run than those assigned to work-first activities.[9] Although studies of the GAIN experiment have the advantage of randomization, the "treatment" of human capital development includes many types of education and training activities, including basic skills training, vocational training, and community college coursework, with limited information on the amount of time spent in these activities and whether training or courses were attended and what, if any, credentials were received.

2.1 Labor market returns to community college attendance

The plurality of U.S. undergraduate students - close to 40 percent in 2011 - attend one of 1,700 community colleges (Snyder and Dillow 2013). Community colleges also contain a large and growing share of federal grant recipients. Aid provided through the Pell Grant Program, the largest source of need-based aid in the United States, grew from $7.2 to $30 billion between 2000 and 2010, with the percentage of recipients attending community colleges increasing from 36 to 57 percent.[10]

[8]Colorado Department of Higher Education, "Student Headcount by Gender: Colorado Public Two-Year Institutions of Higher Education" reports.

[9]Using data on more recent cohorts of welfare recipients in Missouri and North Carolina and an individual fixed effects estimation strategy, Dyke et al. (2006) generate similar findings.

[10]Department of Education 1999-2000 and 2009-2010 Federal Pell Grant Program End-of-Year Reports.

Numerous papers find positive returns to both college attendance and credential receipt in the two-year sector, with estimated earnings gains as high as 13 percent for each year of attendance and 50 percent following the receipt of an associate degree.[11] Kane and Rouse (1995) estimate that each year of community college attendance is correlated with a 7 percent increase in annual earnings of students who completed high school in the 1970s and 1980s. Their results also suggest that female students who complete an associate degree earned 30 percent more than high school graduates. Despite large expansions in the number of students enrolled in community college in recent years, Marcotte et al. (2005) find similar earnings gains among more recent cohorts. Importantly, Marcotte et al. (2005) distinguish between community college students who received sub-associate certificates and those who exit college without a credential and find larger (although not statistically distinguishable) impacts of certificate receipt on earnings than the equivalent number of credits in the absence of any credential.[12]

Results from cross-sectional studies that compare point-in-time labor market outcomes across individuals with different levels of education time may be biased by unobservable factors that affect both the decision to attend college and labor market outcomes (Card 1999). One approach to addressing with this type of selection bias is to use repeated observations of earnings and employment for individuals who are employed both before and after they enroll in college and include individual fixed effects in the empirical specification. With a sufficiently long panel of data, each student's pre-college earnings potentially serves as a counterfactual for what she would have earned had she not gone to school, eliminating concerns of selection on time-invariant characteristics such as ability or motivation. This strategy necessarily excludes "traditional" students who matriculate immediately following high school graduation; however, community colleges increasingly serve older, non-traditional students.[13] Furthermore, many federal job training programs target older workers who have been displaced from previous jobs. The average age of women in my sample who enroll in college following welfare entry is 28.

In the first paper to use an individual fixed-effects approach to examine the returns to community college enrollment, Jacobson, LaLonde and Sullivan (2005) estimate that among high tenure displaced workers in Washington, each year of college leads to a 13 percent increase in women's earnings. The benefits of community college attendance primarily accrue to women who complete technical coursework. Unfortunately,

[11] Belfield and Bailey (2011) provide a summary of the literature on the labor market returns to community college attendance.

[12] Several additional papers use administrative data from specific states and a selection on observables approach to examine the effect of community college attendance on labor market outcomes. Using data from North Carolina, Liu et al. (2015) find no evidence of earnings gains from sub-associate credentials above and beyond the gains due to an equivalent number of credits. Backes, Holzer and Velez (2015) estimate the relationship between community college credential receipt and labor market outcomes among disadvantaged youth in Florida. The authors find that technical credentials are associated with larger earnings gains than credentials earned in general humanities programs.

[13] In 2012, 50 percent of community college students were at least 24 years old and 25 percent were at least 32. Author's calculations using the 2012 National Postsecondary Student Aid Study, via the National Center for Education Statistics' PowerStats application.

the authors can only take into account degree receipt because sub-associate credentials are not observed. Few individuals in their sample remain in college long enough to complete an associate degree. Building upon these findings, Jepsen, Troske and Coomes (2014) use an individual fixed effects approach to examine the impact of credits, credentials, and associate degree receipt on the labor market outcomes of two cohorts of degree-seeking community college students in Kentucky. They estimate that associate degree recipients experience a greater than 50 percent increase in earnings. Certificates requiring two to three semesters of coursework result in similar earnings gains, while the returns to short-term certificates are small. Several additional studies obtain similar results using administrative data on community college students in California (Stevens, Kurlaender and Grosz 2015), Michigan (Bahr et al. 2015), North Carolina (Liu et al. 2015), Washington (Dadgar and Trimble forthcoming), and North Carolina and Virginia (Xu and Trimble 2014).

3 Data and Descriptive Results

My underlying sample consists of 29,556 adult welfare recipients who entered Colorado's welfare system, Colorado Works, between the third quarter of 2004 and second quarter of 2007. I use program data which contains the universe of individuals who received any assistance from Colorado's TANF program (Colorado Works) beginning September 2004. The small number of adult male recipients and women who were younger than 19 or older than 60 at entry are excluded. I observe monthly welfare receipt between entry and the first quarter of 2010 as well as a variety of characteristics including age, race, marital status, number of children, lifetime months of assistance, whether the individual is listed as having a disability, and whether she owns a vehicle. Moreover, I observe changes in time-varying individual characteristics (e.g., marriages, births, becoming disabled) that are potentially correlated with both the decision to enroll in college and labor market outcomes.[14]

Individuals are linked to information from the Colorado Department of Higher Education which covers individuals' lifetime college attendance at public institutions in Colorado including program of study, cost of attendance, financial aid, and credit and credential receipt. I convert semesters attended to quarters, with the fall semester corresponding with the fourth quarter, winter/spring semester corresponding to first and second quarters, and the summer semester corresponding to the third quarter of a year. My sample includes the small number of women who attended four-year institutions, either prior to or following welfare receipt, although my results are robust to excluding these individuals. Finally, sample members are matched to data on quarterly earnings and employment in all covered sectors from the Colorado Department of Labor for the

[14]Unfortunately, I only observe these time-varying characteristics when individuals are receiving welfare benefits. For individuals who leave welfare, I use the last reported value of these characteristics. If individuals leave and return to welfare, I smooth the imputation of characteristics between spells.

29 quarters between the third quarter of 2003 and the fourth quarter of 2010, resulting in 857,124 person by quarter observations.

3.1 Characteristics of recipients by post-entry college attendance

Table 1 displays the characteristics of the women in my sample, distinguishing between women who do not enroll in college following welfare entry, women who enroll but did not obtain a credential, and credential recipients. The fourth column includes women who were already enrolled in college for at least two quarters at entry rather than those who were induced to enter college after entering Colorado's welfare program (however, their pre-welfare labor market attachment is no weaker than that of women in the other groups). College-going women are slightly younger, are more likely to own vehicles, and are slightly less likely to be disabled. A portion of women in all four groups have some past experience with higher education. For instance, 34 percent of women who attend college and earn a degree following welfare entry enrolled in college for at least one semester prior to welfare entry. Finally, women who enroll in college following entry have higher pre-welfare earnings and employment, suggesting that estimates that do not account for individual effects may be biased upwards.

The bottom portion of Table 1 contains information pertaining to the educational attainment and labor market outcomes I examine. Credential recipients earn close to 70 credits after welfare entry. The majority of these women earn a short-term vocational certificate, which require between 15 to 30 credits (one to two semesters of full-time attendance), 14 percent earn a certificate requiring between 30 and 60 credits (two to three semesters of full-time attendance), and 28 percent earn an associate degree.[15] Associate degrees require between 60 and 90 credits of coursework. Associate of arts and associate of general studies (AA/AGS) degrees are designed for students who intend to transfer to a four-year program, and while these degrees may be awarded in specific areas (e.g., agricultural science), the vast majority are liberal arts degrees. Conversely, associate of applied science (AAS) degrees are terminal and apply to specific, primarily technical fields.[16] Women who enroll in college following entry but do not earn a degree spend less time in school and only earn 19 credits, on average.

Following welfare entry, college-going women initially earn less, on average, than women who do not attend college. But four years following welfare entry, college drop-outs earn approximately $400 more per quarter than their counterparts who do not attend college, while degree recipients earn over $1000 more.

[15] Common examples of certificates awarded to welfare recipients include real estate, computer information systems, emergency medical services, and nurse assistant/home health aid.

[16] On average, credential recipients earn more credits than the minimum required. Restricting the same to women who only obtain one type of credential after welfare entry, I estimate that short-term certificate recipients earn 32 credits, certificate recipients earn 85 credits, AAS degree recipients earn 128 credits, and AA/AGS recipients earn 162 credits.

3.2 Graphical analysis

Figure 2 previews my main approach and results. Panel A of Figure 2 displays unadjusted average earnings by quarter, both before and following welfare entry. The black solid line indicates individuals who attend college following entry into Colorado Works but do not earn a credential following entry (drop-outs), the thick dashed line represents the earnings trajectories of degree recipients, and the gray line represents the earnings of women who do not attend college prior to or following welfare entry. I exclude women who were already enrolled in college at entry (described in the fourth column of Table 1). Thin dotted lines represent 95 percent confidence intervals.

Earnings of all groups experience an "Ashenfelter dip" in the quarters immediately surrounding welfare entry. All sample members experience a decline in earnings in the two to three quarters before and following welfare entry. Up to three years after welfare entry, degree recipients have lower earnings than other women, likely due to a greater number of quarters spent in college. Conversely, drop-outs appear to have much lower foregone earnings, but their earnings gains following welfare entry are small. Beginning in the 12th quarter after entry, the earnings of degree recipients significantly exceed both the earnings of other groups and their own pre-welfare earnings, although these gains are imprecisely estimated due to the small group size.

Panel B of Figure 2 replicates this exercise, graphing residual earnings from a regression on individual fixed effects. The dashed line without a confidence interval represents the average quarterly county unemployment rate. The largest earnings gains to degree recipients accrue at the end of the sample period, when unemployment is increasing. During this same period, the residual earnings of college drop-outs and women who do not attend college are indistinguishable and decline to below pre-entry levels at approximately 18 quarters after entry.

4 Empirical Framework

Simple regressions of labor market outcomes on college enrollment will be biased if the decision to attend college is correlated with unobservable individual characteristics that also affect employment and earnings. Selection bias is likely a concern even among welfare recipients as London (2006) shows that women attending college while on welfare prior to PRWORA had higher test scores and were more likely to have a two-year institution in their county of residence than other recipients.

To address this concern, I follow an empirical approach similar to Jacobson, LaLonde and Sullivan (2005), taking advantage of the fact that I observe earnings for women both before and after welfare receipt. If selection bias is only driven by time-invariant unobservable characteristics, then including an individual fixed

effect will deal with the endogeneity of college attendance and credential receipt. Essentially, this approach differences out a person-specific mean level of wages from observed quarterly wages, using observations of individuals' wages prior to college attendance as a counterfactual for current wages in the absence of college-going. Additionally, I include observations of individuals who do not attend college to identify year and quarter fixed effects and the impacts of other observable characteristics. The key identifying assumption is that there are no time-varying unobservable shocks correlated with educational attainment and labor market outcomes that affect college-going women differentially than other recipients.

I estimate the following linear regression model:

$$y_{it} = \alpha_i + \delta_i t + \boldsymbol{\gamma_t} + \sum_{k=t-entry} \lambda_k d_{it}^k + \mathbf{x_{it}}\boldsymbol{\beta} + \eta e_{it} + f\left(s_{it}, \mathbf{c_{it}}, \boldsymbol{\tau}\right) + \varepsilon_{it} \tag{1}$$

Where y_{it} is the outcome of interest (i.e., quarterly earnings, probability of employment) for individual i in quarter t. The first three terms in equation (1) account for unobservable individual and period-specific factors that affect labor market outcomes: α_i is an individual fixed effect that controls for time-invariant, person-specific unobservable qualities, such as ability or motivation, $\delta_i t$ allows for individual-specific linear trends in outcomes, and α_t is a quarter-specific fixed effect that controls for aggregate shocks that affect all individuals in a given period. The fourth term allows for labor market outcomes to vary in the quarters before and after welfare entry, with d_{it}^k indicating whether the current period is k quarters before or after entry. $\mathbf{x_{it}}$ is a vector of time-varying observable individual characteristics, including a quadratic term in age (allowed to vary by race/ethnicity), number of children, age of youngest child, vehicle ownership, and indicators for months of lifetime welfare receipt (0 months, 1 to 12, 13 to 24, 25 to 59, and 60 or more months).[17] All specifications also include quarterly county unemployment rates from the Bureau of Labor Statistics' Local Area Unemployment Statistics program.

The next two terms allow earnings to vary within and following schooling. First, e_{it} is an indicator for whether the individual is enrolled in college during period t. Finally, $f(\cdot)$ is a function of credits (s_{it}) and credentials ($\mathbf{c_{it}}$) received following college enrollment. Under the identifying assumption that - conditional on the observable characteristics in $\mathbf{x_{it}}$ and unobservable individual-specific effects, time-trends, and quarter-specific effects - the unobserved error term ε_{it} is uncorrelated with schooling choices and the vector of parameters, $\boldsymbol{\tau}$, contains estimates of the causal effect of educational attainment on labor market outcomes. My main parametrization of $f\left(s_{it}, \mathbf{c_{it}}, \boldsymbol{\tau}\right)$ includes indicators for credential receipt and a a linear term in

[17] These intervals correspond to cut-offs that trigger changes in Colorado welfare rules. For instance, two thirds of a participant's income is disregarded from benefit calculation for the first twelve months of participation. After 24 months of assistance, recipients are required to participate in at least 20 hours of work related activities per week (e.g., employment, job search, on the job training). Finally, Colorado follows the federal 60 month lifetime limit on benefit receipt (although some participants are granted extensions for extenuating circumstances).

credits received interacted with an indicator for not having earned a credential: $f(\cdot) = \tau_1 s_{it} \mathbf{1}[c \in \{D^c\} = 0] + \sum_c \tau^c D^c$, where D^c indicates receipt of specific credentials.[18] With this specification, I can test whether college drop-outs benefit from earning additional credits and whether earnings and employment gains are larger for particular credentials. I also explore whether my findings are robust to different assumptions over the function form of $f(s_{it}, \mathbf{c_{it}}, \boldsymbol{\tau})$, which are described in the following section.

5 The Impact of Community College Credits and Credentials on Labor Market Outcomes

Table 2 presents estimates of the impact of community college credits and credentials and bachelor's degree receipt on quarterly earnings and employment from equation (1). Columns 1 and 4 display estimates from cross-sectional models that exclude individual fixed effects and trends, the estimates in columns 2 and 5 come from models that include individual fixed effects, and the final two columns contain estimates from models that include both individual fixed effects and individual-specific trends. In each specification, I test (1) whether the impact of a year of full-time attendance in the absence of credential receipt is equal to the impact of a short-term certificate, (2) whether the two types of associate degrees I observe lead to equally sized improvements in labor market outcomes, and (3) the equality of impacts across all credentials (including bachelor's degrees); p-values from these tests are displayed in the bottom panel of Table 2.

Estimates from models that only use cross-sectional variation in attainment suggest that a year of full-time college attendance (30 credits) associated with a $238 increase in quarterly earnings (an approximately 14 percent increase over mean pre-welfare earnings of women who enroll in college following welfare entry) and a 3.5 percentage point increase in the probability employment (a 7 percent increase). However, after controlling for time-invariant individual-specific characteristics via individual fixed effects, the estimated impact of community college credits is no longer statistically distinguishable from zero. The addition of individual-specific trends in labor market outcomes further decreases the magnitude of the estimated impact of community college credits. Taken together, the cross-sectional and fixed effects estimates suggest that individuals who attend community college but do not earn a credential would have experienced greater earnings gains over time compared to other women in the sample, even in the absence of college enrollment.

All vocational degrees and credentials offered by Colorado community colleges lead to significant increases in quarterly earnings. Even short-term certificates, requiring less than one year of full-time attendance, increase earnings by over $400 per quarter (a 24 percent increase from pre-welfare earnings). Across spec-

[18] The indicators for credential receipt are not mutually exclusive, as sample members may earn more than one type of credential.

ifications, the estimated impacts of short-term certificate receipt are quite similar, suggesting that women who earn these credentials are not positively selected relative to other welfare recipients in terms of their pre-college earnings profiles. Longer term certificates result in larger earnings gains, although the magnitude decreases when individual fixed effects and linear trends are included. In my preferred specification, which includes individual fixed effects and linear trends, certificate recipients experience a $700 (42 percent) increase in quarterly earnings. The estimated impact of AAS degree receipt increases in magnitude when individual fixed effects and trends are included, suggesting that AAS degree recipients had worse earnings trajectories prior to college attendance relative to women who did not attend college, on average. In my preferred specification, women who earn AAS degrees experience the largest earnings gains, equal to $2,200 per quarter (a 133 percent increase). Receipt of AA/AGS degrees only leads to small, marginally significant increases in quarterly earnings. Bachelor's degree recipients see similar earnings gains, but the number of such individuals in my sample is quite small, so estimates relating to the outcomes of four-year college graduates should be interpreted with caution.

All credentials appear to increase the probability of post-college employment. Estimates from my preferred specification (column 6) suggest that credential recipients experience a 12 to 21 percentage point increase in the probability of employment in a given quarter (equal to a 24 to 43 percent increase in employment relative to pre-welfare entry outcomes). Consistent with the estimated impacts on earnings, AAS degree recipients' employment gains are largest in magnitude, albeit not statistically distinguishable from the estimated employment gains from other credentials.

The final row of Table 2 contains estimates of the foregone earnings and employment due to college attendance. Estimates from my preferred specification in columns 3 and 6 suggest that women who enroll in college would have earned $530 more and would have been 8.2 percentage points more likely to be employed per quarter had they not been attending college.

5.1 Robustness

I subject the estimates to a variety of robustness tests. First, I examine whether my estimates are affected by four separate sample restrictions. To eliminate concerns that my results are driven by a negative correlation between employment and post-entry college attendance, I limit my sample to women with a strong pre-welfare labor market attachment. Second, I eliminate women who were already attending college before entering welfare. Third, I eliminate individuals who are still enrolled in college at the end of my sample period. Finally, I drop observations from the quarters surrounding welfare entry in which earnings display a dip. As shown in Table 3, these estimates are quite consistent with those generated from my preferred

specification in Table 2 (columns 3 and 6). I find little evidence of earnings or employment gains from earning additional community college credits, large impacts of certificates and AAS degrees on earnings, small and largely insignificant earnings gains following AA/AGS degree receipt, and large increases in employment following the receipt of any community college credential.

Next, I test whether my results are robust to different parametrization of $f(s_{it}, \mathbf{c_{it}}, \boldsymbol{\tau})$; results presented in Table 4. Jacobson, LaLonde and Sullivan (2005) estimate models that allow for both a discrete impact of any college enrollment and gains that are proportional to the number of credits earned. Their results suggest that "just showing up" in college increases women's earnings by 5.5 percent, which could be attributed to gains from networking or nonacademic services provided by community colleges. In contrast, when I estimate models that allow for a discrete impact of community college attendance, I find evidence of a statistically significant negative impact on earnings equal to $181 per quarter and a negative but statistically insignificant impact on the probability of employment (Table 4, columns 1 and 4).

I test for nonlinearities in the impact of credits earned on labor market outcomes by replacing the continuous measure of credit receipt with discrete categories of credits earned.[19] As shown in column 2 of Table 4, women who earn between 1 and 45 credits experience an approximately $200 decrease in their post-college earnings, whereas the earnings impacts for individuals who earn more than 45 credits but no credential is not statistically distinguishable from zero. I find no evidence of a statistically significant relationship between credits earned and quarterly employment (column 5).

Finally, I test whether some of the benefits from shorter-term credentials come from the fact that they enable women to earn a longer-term credential or degree by setting the indicator for receipt of a specific credential to zero when a sample members earns a higher credential. Approximately 17 percent of bachelor's degree recipients also earned an AA/AGS degree by the end of my panel. An additional 7 percent of women with a bachelor's degree also had earned an AAS degree and 4 percent received any type of certificate. Likewise, 20 percent of AAS degree recipients and 12 percent of AA/AGS recipients had also earned certificates by the end of my panel. Although AAS and AA/AGS degrees generally require an equal number of credits, I allow AAS degrees to supersede AA/AGS degrees.[20] As shown in columns 3 and 6 of Table 4, the estimated impacts of credential receipt on earnings and employment are quite similar to those displayed in Table 2, suggesting that the impacts of receiving a short-term credential are not solely driven by the increased probability of earning a higher degree.

[19] In the latter case, the categories include 1-15 credits (1 semester of full-time attendance), 16-30 credits (2 semesters of full-time attendance), 31-45 credits (3 semesters of full-time attendance), 46-60 credits (4 semesters of full-time attendance), and 61 or more credits (more than 4 semesters of full-time attendance).

[20] There is very little overlap between AAS and AA/AGS degree recipients; only 4 percent of AAS recipients also hold AA/AGS degrees and 6 percent of AA/AGS recipients only AAS degrees. Estimates from specifications that treat AA/AGS degrees as superseding AAS degrees yield quite similar results.

Thus far, my empirical approach does not allow earnings or employment gains due to community college attendance to vary over time. To allow for a transition period after school exit, I follow Jacobson, LaLonde and Sullivan (2005) and include a set of interactions between credit/credential receipt and the reciprocal of the number of quarters since college exit. In the long-run, this term goes to zero; thus the long-run impact of credit and credential receipt will be approximated by the coefficient on the main effect of credits and credentials.[21] As shown in column 1 of Table 5, although community college students do experience a marginally significant increase in earnings as they transition from college to the labor force, I find little evidence that the long-run impacts of credits and credentials vary substantially from the earnings gains experienced shortly after college exit.[22] Conversely, the results shown in column 2 suggest that the relationship between college attendance and employment declines as the time since college exit grows for all students except AA/AGS recipients.

5.2 Heterogeneity by area of study

Most studies examining the labor market impacts of community college attendance find evidence of heterogeneous gains across programs, with programs in allied health and technical areas resulting in the largest labor market benefits. To test whether these findings hold in my setting, I fully interact the terms for credit and credential receipt with an indicator for whether the credits or credential were earned in a program related to health, math, or science.[23] As shown in columns 1 and 3 of Table 6, credits from health, math, or science programs do not increase earnings or employment in the absence of credential receipt. Longer-term health, math, and science certificates and AAS degrees lead to larger earnings gains than certificates and AAS degrees from other programs. The earnings gains from short-term certificate receipt do not vary significantly by program. All community college credentials in all areas of study increase employment, and employment impacts due to health, math, and science credential receipt are statistically indistinguishable from impacts due to credential receipt in other areas.

In many sources of data containing community college students, sub-associate credentials are not observed. For example, Jacobson, LaLonde and Sullivan (2005) do not observe whether individuals in their sample earn certificates. To determine whether my finding that credits earned in health, math, and science fields do not lead to statistically significant earnings gains can be attributed to the fact that I observe cer-

[21] Jacobson, LaLonde and Sullivan (2005) evidence of significant increases in the impact of college attendance in the first year after college exit. Jaggers and Xu (2015) use an alternative approach to estimate how the impact of community college attendance on labor market outcomes varies over time using administrative data from the Virginia Community College System and a piecewise growth curve approach. Their estimates suggest that associate and bachelor's degree recipients experience stronger growth in earnings after leaving college than certificate recipients.

[22] I also estimate models that include interactions between credit/credential receipt and separate indicators for whether the individual was in the first through eighth quarter since college exit or nine or more quarters from exit. Results (available upon request) suggest that all of the growth in earnings following college exit occur within the first three quarters.

[23] Unfortunately, due to the small number of women who attend college, I cannot further disaggregate programs of study.

tificate receipt, I estimate models that treat certificates as unobservable. As shown in column 2 of Table 6, I estimate a positive and statistically significant impact of credits earned in math, health, and science programs on earnings (but not employment). When certificates are unobservable, estimates erroneously suggest that credits from one year of full-time attendance in these programs leads to a $175 increase in quarterly earnings (approximately an 10 percent gain over pre-welfare earnings).

On average, credential recipients in my sample complete more credits than the minimum required for a given certificate or degree.[24] Thus, I test whether credential recipients experience additional labor market benefits from earning additional credits and whether these effects vary according by program. To do so, I interact the indicators for credential receipt with a measure of the number of additional credits earned beyond the minimum required for the specific credential. As shown in Table 7, women who earn certificates and AAS degrees in health, math, and science fields experience substantial earnings gains from additional credits. Unfortunately, I do not observe the actual number of credits required for a given program, thus, these results may reflect the fact that programs that require more than the minimum number of credits also produce larger returns. I find no evidence of additional increases in employment due to the receipt of credits beyond the minimum required for a given credential.

6 Private Returns Over the Short- and Medium-Run

To approximate the private returns to college attendance, I need to make several simplifying assumptions. I first calculate the average number of quarters spent enrolled by credential receipt, treating women who enroll in college but do not receive a credential as a separate group. The total costs associated with college attendance include direct costs (tuition and fees) and forgone earnings. I assume that all college students forgo $530 in earnings per quarter they are enrolled, based on the estimates in Table 2 and calculate the average tuition and fees paid while enrolled separately by credential receipt.[25] Women in my sample receive both cash welfare and financial aid while enrolled in college. Thus, for each group, I calculate the average amount of financial aid (grants and loans) and cash assistance received while in college.[26] Finally, to account for the fact that the additional earnings due to college attendance may grow over time, I use the estimates

[24] Including credits from required, optional, and remedial courses, short-term certificate recipients earn 27 credits on average, 12 more than the minimum required for the credential. Certificate recipients earn an additional 40 credits above the minimum required and AAS degree recipients earn an additional 52 credits. On average, AA/AGS recipients earn 80 credits beyond the 60 required for degree receipt.

[25] I only observe the total cost of attendance (COA) faced in a given semester. COA includes tuition, fees, and - for students who are enrolled at least part-time - estimated living expenses. Since students face living expenses whether or not they attend college, I assume that the tuition and fees portion of COA equals COA$*\frac{2}{3}$.

[26] Between 42 and 47 percent of students' financial aid is in the form of loans. I treat loans as grant aid while in school. I assume that loans do not accrue interest while students are enrolled in college (as is the case with federal subsidized loans). After school exit, I assume students face a 5 percent interest rate and repay their loans over 10 years following the standard federal repayment plan.

displayed in Table 5 to generate average annual earnings gains by years since college exit. I subtract estimated annual payments on student loans from these earnings gains. The costs and net returns by credential receipt are shown in Table 8, with the final row displaying the estimated number of years since college entry to break even.[27]

Community college drop-outs spend an average of 7 quarters enrolled in college. After taking into account forgone earnings, direct costs, cash assistance, and financial aid, these students leave college with close to a net loss of almost $11,000. Since these students do not experience any earnings gains and must repay their student loans, they never recoup their lost resources. Short-term certificate recipients spend the shortest amount of time in college - only 4 quarters, on average. As a result, the net cost associated with college enrollment is also low. However, the earnings gains from receipt of a short-term certificate are less than $2000 per year. After taking into account student loan payments, it takes these women 7 years to experience a positive net return to college attendance. Certificate recipients experience larger earnings gains following college exit, but these women also spend a longer period in college (9 quarters, on average). Certificate recipients do not recoup the total costs associated with college until 9 years after initial enrollment. Despite spending the longest time enrolled in college, women who earn AAS degrees are the quickest to obtain net positive returns. These women spend 13 quarters enrolled in college, on average, but due to the large earnings gains they experience upon entering the labor market, they quickly recover their losses. Ten years after college entry, the private return to college attendance resulting in an AAS degree is close to $30,000. In contrast, AA/AGS recipients leave school after 11 quarters of enrollment with close to $9,000 in losses. For these women, the estimated earnings gains from degree receipt are lower than the required student loan payments. After 10 years, when these women have fully paid off their loans, they can begin to recover from their losses, but it takes a full 20 years to fully recover from the costs associated with earning an AA/AGS degree.

7 Conclusion

Using an individual fixed effects approach, I find that women at risk for welfare receipt benefit from college attendance, although the impacts are driven by credential receipt. Even women who receive a certificate for less than one year of full-time study see their earnings increase by over $400 per quarter. These are significant gains, given that on average, these women only earned $1,700 per quarter prior to welfare entry. Women who earn a terminal associate degree see their earnings increase by approximately $2,200 per quarter. Certificates and AAS degrees earned in health, math, and science programs lead to larger earnings gains

[27] I assume a 3 percent discount rate.

than those earned in other programs. However, health, math, and science credits do not increase earnings or employment in the absence of credential receipt.

My findings are largely consistent with estimates from other studies examining the impact of community college credentials on labor market outcomes, with one notable exception. Across a variety of settings, short-term certificates are estimated to have small, insignificant impacts on the average community college student's earnings (Jepsen, Troske and Coomes 2014; Bahr et al. 2015; Liu et al. 2015; Dadgar and Trimble forthcoming). In contrast, my estimates suggest that receipt of a short-term certificate increases quarterly earnings by approximately 24 percent. There are several possible explanations for why my estimates diverge from prior findings. It could be that the population I focus on - single mothers with limited labor market opportunities - is served well by these short programs. Alternatively, Colorado community colleges may offer a different mix of short-term certificate programs than schools in other states. Finally, welfare recipients must have their program of study approved by a case manager for college attendance to count towards fulfilling their work participation requirements. This additional oversight may help recipients choose programs that will eventually lead to better labor market prospects.

Despite the potentially large labor market returns to credential completion over the longer-run, most community college students leave school without receiving a degree or certificate. For instance, among students who first entered a community college in fall 2003, only one-third had completed a credential six years later (Radford et al. 2010). Among women in my sample, completion rates are even lower: only 10 percent of women who attend college after entering Colorado's welfare program obtain a credential. While college attendance has continued to rise over the last several decades, completion rates in both two- and four-year institutions have fallen (Bound, Lovenheim and Turner 2010). Leaving college without a certificate or degree is not necessarily suboptimal if potential students are uncertain of their individual returns or ability to succeed in college prior to enrollment (e.g., Manski 1989; Stange 2012; Stinebrickner and Stinebrickner 2012; Stinebrickner and Stinebrickner 2014). Community college students' high drop-out rates could also be due to credit constraints. Among women in my sample, even AAS degree recipients do not recoup the costs associated with college attendance until 5 years after they first enroll. Many community college students cycle between full-time employment and college attendance and recent research suggests that enrollment intensity and continuity are important predictors of credential completion (e.g., Crosta 2014). Without a source of exogenous variation in credit constraints and information, it is difficult to determine the extent to which these factors affect completion rates.

My findings are subject to important limitations. I only observe individuals for a limited period of time following welfare entry, thus, without additional assumptions over earnings growth after this period, I can only estimate the effect of credentials on labor market outcomes over the medium term. If some credentials,

such as AA/AGS degrees, take longer to produce earnings gains, my estimates will not represent the long-run impact of higher education. Second, if time-varying unobservable characteristics are correlated with both the decision to attend college and outcomes, my estimates will include this selection bias. Finally, I only observe college attendance and credential receipt at public institutions in Colorado. It is likely that some women in my sample attended one of the many private technical schools licensed to operate in Colorado. If the earnings gains due to credentials earned at private two-year institutions are similar to those generated by community college credentials (e.g., Cellini and Chaudhary 2014), my estimates likely represent a lower bound of the returns to higher education.

Nonetheless, my results have implications for how policy targeting the two-year sector of higher education can positively impact the labor market outcomes for low-skilled individuals. In particular, these results suggest that efforts aimed at increasing completion of a credential, even short-term certificates, can substantially increase earnings. Given that two-year college students generally face low probabilities of credential completion, my results suggest that the marginal student induced to enter college may not benefit substantially unless additional supports for credential completion are provided.

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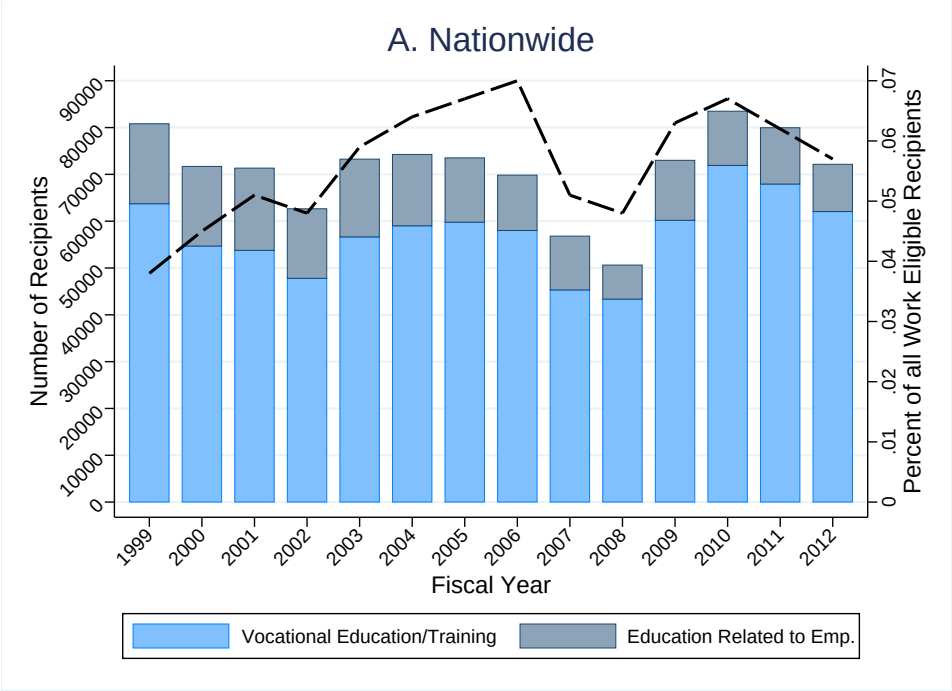
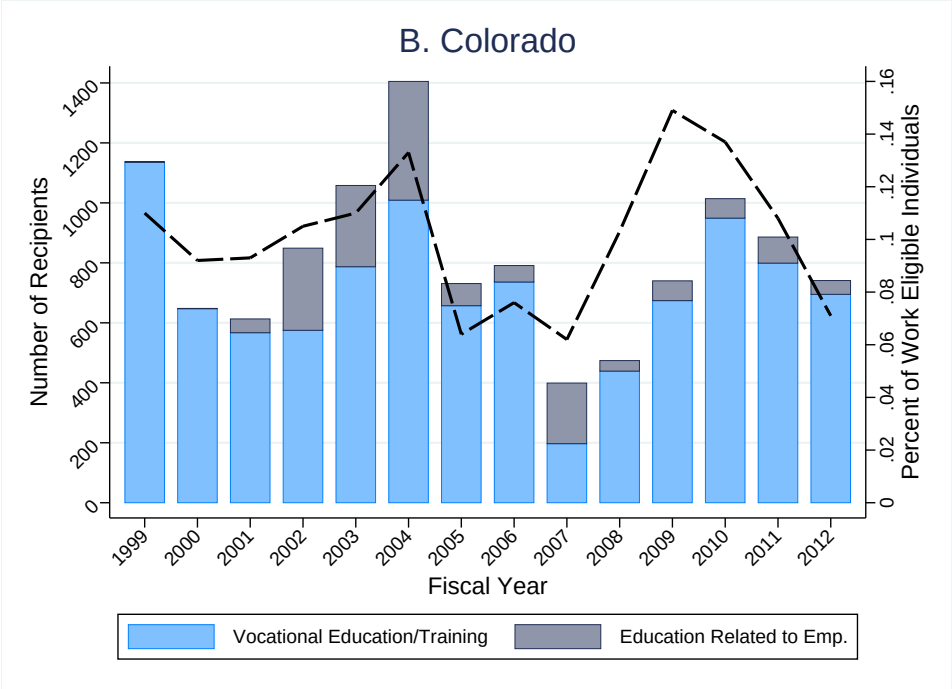
Figures and Tables

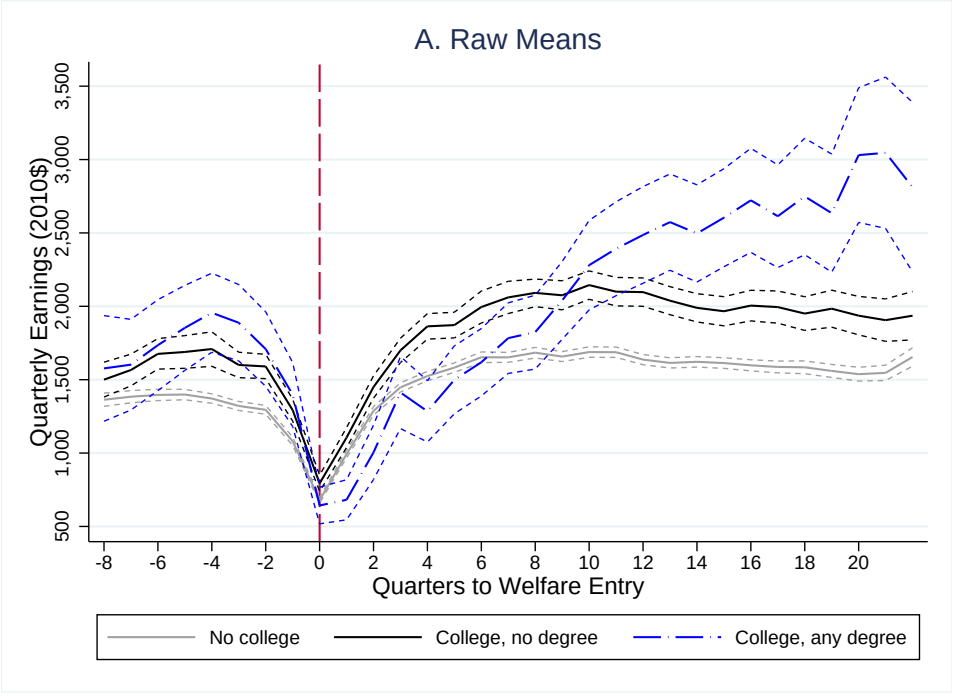
Figure 1: The Number and Share of Welfare Recipients Participating in Education-Related Activities

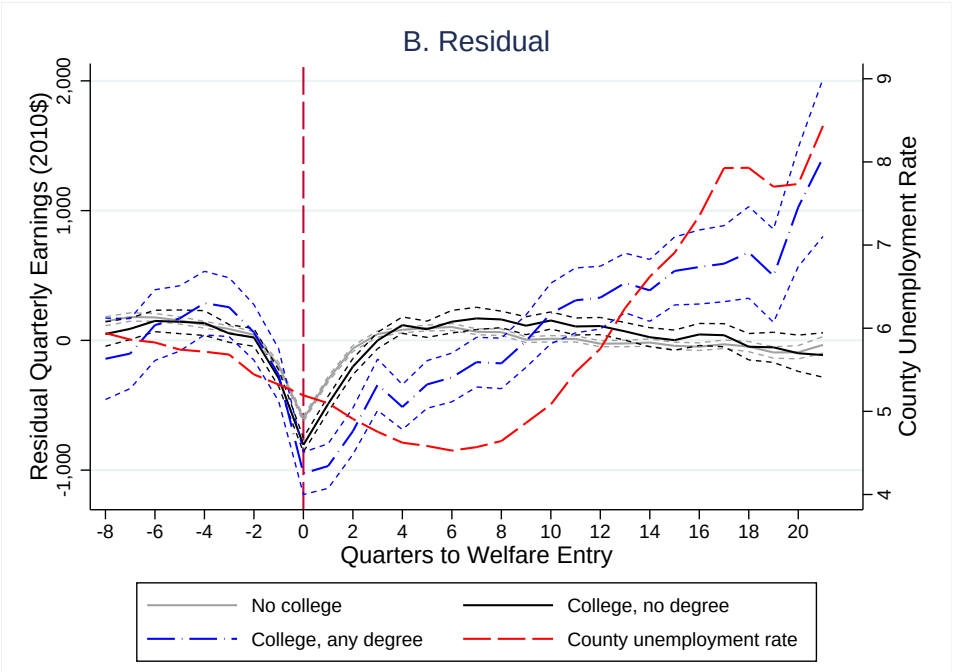




Source: US Department of Health and Human Services, Administration for Children and Families Office of Family Assistance annual Work Participation Rate reports; available at: http://www.acf.hhs.gov/programs/ofa/programs/tanf/data-reports. Education-related activities are those that potentially count towards meeting federal work participation requirements.

Figure 2: Average Quarterly Earnings by Educational Attainment following Welfare Entry





Source: Colorado Department of Human Services (CDHS) program data, Colorado Department of Labor (CDLE) quarterly earnings records, and Colorado Department of Higher Education (CDHE) enrollment and degree files. *Notes*: Sample includes female adult welfare recipients who began a spell of welfare receipt between October 2004 and June 2007. Thick lines represent average quarterly earnings (Panel A) or residual earnings from a regression on individual fixed effects (Panel B) before and after welfare entry by educational attainment and credential receipt. Thin dashed lines represent 95 percent confidence intervals. In Panel B, the thick dashed line represents the average county unemployment rate faced by sample members during the specified quarter. All dollar amounts adjusted for inflation using the CPI-U (2010$).

Table 1: Characteristics of Colorado Works Recipients by College Attendance and Credential Receipt

	No College	College Attendance		In College
		No Degree	Any Degee	Pre-Entry
Number of individuals	23,115	3,329	380	2,732
Race				
Hispanic	0.31	0.28	0.32	0.28
Native American, Asian, or Pacific Islander	0.04	0.04	0.03	0.04
Black	0.17	0.21	0.12	0.2
White	0.49	0.47	0.53	0.48
Characteristics at welfare entry				
Age	30	28	28	28
Never married	0.53	0.59	0.58	0.60
Number of children	2.0	1.9	1.8	1.9
Age of youngest child	4	4	3	4
Lifetime months on welfare	9	9	6	11
First spell on welfare	0.20	0.22	0.23	0.16
Own vehicle	0.29	0.34	0.39	0.40
Disabled	0.13	0.10	0.08	0.12
Average quarterly earnings before entry	$1,357	$1,642	$1,768	$1,544
Fraction of quarters employed before entry	0.41	0.49	0.52	0.51
Prior college attendance (1990 or later)	0.15	0.27	0.34	1.00
Prior credits earned (1990 or later)	4	10	19	50
Outcomes				
Fraction of quarters employed after entry	0.40	0.51	0.53	0.51
Average quarterly earnings				
All quarters after entry	$1,589	$1,870	$2,092	$2,119
1 year after entry	$1,549	$1,890	$1,293	$1,839
2 years after entry	$1,707	$2,139	$1,854	$2,298
3 years after entry	$1,654	$2,133	$2,541	$2,510
4 years after entry	$1,614	$2,017	$2,765	$2,456
Fraction of quarters on welfare	0.25	0.29	0.32	0.28
Fraction of quarters in school	0	0.24	0.42	0.23
Credits earned	0	19	67	25
Degree received				
Certificate (less than 1 year)	0	0	0.53	0.03
Certificate (1 to less than 2 years)	0	0	0.14	0.02
Associate of Arts/General Studies	0	0	0.17	0.05
Associate of Applied Science	0	0	0.11	0.02
Bachelor's Degree	0	0	0.05	0.04

Source: CDHS program data, CDLE quarterly earnings records, and CDHE enrollment and degree files. *Notes:* Sample includes female adult welfare recipients who began a spell of welfare receipt between October 2004 and June 2007. Categories based on college-going after entering welfare. Race and marital status only reported for women with non-missing values. All dollar amounts adjusted for inflation using the CPI-U (2010$).

Table 2: The Impact of College Credits and Credentials on Labor Market Outcomes

	Dependent variable = quarterly earnings			Dependent variable = Pr(employed)		
	(1)	(2)	(3)	(4)	(5)	(6)
No degree × credits earned	7.92	0.91	-0.13	0.001	0.0001	-0.00006
	(0.78)**	(0.62)	(0.63)	(0.0001)**	(0.0001)	(0.0001)
Point estimate: credits × 30	*238*	*27*	*-4*	*0.035*	*0.003*	*-0.002*
	*(23)***	*(19)*	*(19)*	*(0.003)***	*(0.003)*	*(0.003)*
Degree:						
Short-term certificate	434	477	416	0.092	0.104	0.119
	(88)**	(119)**	(133)**	(0.013)**	(0.020)**	(0.025)**
Certificate	916	1127	694	0.095	0.120	0.119
	(159)**	(236)**	(223)**	(0.019)**	(0.027)**	(0.034)**
Associate of applied science	1439	2307	2200	0.137	0.158	0.210
	(193)**	(355)**	(296)**	(0.019)**	(0.030)**	(0.039)**
Associate of arts/general studies	307	-131	432	0.058	0.023	0.149
	(181)+	(179)	(235)+	(0.023)*	(0.034)	(0.043)**
Bachelor's degree	2152	2671	1482	0.129	0.202	0.144
	(257)**	(291)**	(301)**	(0.019)**	(0.032)**	(0.044)**
Enrolled	-125	-561	-530	0.009	-0.069	-0.082
	(37)**	(29)**	(27)**	(0.006)	(0.006)**	(0.005)**
Observations	857,124	857,124	857,124	857,124	857,124	857,124
Test of equality (*p* -value; reject if <0.1):						
30 credits = short-term certificate	0.030	<0.001	0.002	<0.001	<0.001	<0.001
AAS = AA/AGS	<0.001	<0.001	<0.001	0.008	0.003	0.300
All credentials	<0.001	<0.001	<0.001	0.055	0.003	0.358
Individual fixed effects		X	X		X	X
Individual time trends			X			X

Source: CDHS program data, CDLE quarterly earnings records, CDHE enrollment and degree files. *Notes*: Robust standard errors clustered by individual in parentheses; ** p<0.01, * p<0.05, + p<0.1. Each column contains estimates from a separate regression. Regressions also include controls for vehicle ownership, number of children, age of youngest child, presence of a disability, months on cash assistance (0, 1 to 12, 13 to 24, 25 or more), county unemployment rate, a quadratic in age fully interacted with race (white, black, Hispanic, and other), quarter-by-year fixed effects, and quarters since welfare entry fixed effects. Column 1 and 4 specifications include race main effects. Column 2, 3, 5, and 6 specifications include individual fixed effects. Column 3 and 6 specifications include individual linear trends. All dollar amounts adjusted for inflation (2010$).

Table 3: Robustness of Estimated Impacts to Alternative Sample Restrictions

	Dependent variable = quarterly earnings				Dependent variable = Pr(employed)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No degree x credits earned	0.04	-0.84	-0.21	-0.36	-0.0001	0.00002	-0.00003	-0.0001
	(0.79)	(0.92)	(0.69)	(0.65)	(0.0001)	(0.0002)	(0.0001)	(0.0001)
Degree:								
Short-term certificate	398	657	436	368	0.121	0.163	0.119	0.109
	(164)**	(171)**	(135)**	(173)**	(0.029)**	(0.032)**	(0.026)**	(0.029)**
Certificate	877	568	655	691	0.121	0.077	0.106	0.128
	(260)**	(241)*	(232)**	(267)**	(0.041)**	(0.059)	(0.035)**	(0.037)**
Associate of applied science	2449	2378	2226	2074	0.220	0.317	0.203	0.210
	(342)**	(485)**	(302)**	(313)**	(0.044)**	(0.072)**	(0.040)**	(0.040)**
Associate of arts/general studies	226	779	396	383	0.101	0.170	0.154	0.114
	(249)	(292)**	(245)	(228)+	(0.052)+	(0.077)*	(0.045)**	(0.044)*
Bachelor's degree	1082	1763	1529	1650	0.042	0.179	0.152	0.138
	(383)**	(776)*	(312)**	(317)**	(0.053)	(0.112)	(0.044)**	(0.047)**
Observations	525,886	777,896	813,653	620,676	525,886	777,896	813,653	620,676
Test of equality (p-value; reject if <0.1):								
30 credits = short-term certificate	0.017	<0.001	0.001	0.029	<0.001	<0.001	<0.001	<0.001
AAS = AA/AGS	<0.001	0.005	<0.001	<0.001	0.081	0.162	0.417	0.116
All credentials	<0.001	0.014	<0.001	<0.001	0.124	0.129	0.357	0.332
Strong labor force attachment	X				X			
Not in school pre-entry		X				X		
Not in school at end of sample			X				X	
4+ quarters from entry				X				X

Source: CDHS program data, CDLE quarterly earnings records, and CDHE enrollment files. *Notes*: Robust standard errors clustered by individual in parentheses; ** p<0.01, * p<0.05, + p<0.1. Each column denotes a separate regression. All regressions include individual fixed effects and linear trends. See Table 2 notes for description of additional control variables. Regressions displayed in columns 1 and 5 exclude women who were employed for less than 50 percent of the quarters before welfare entry, columns 2 and 6 exclude women who were enrolled in one of the three quarters prior to entry, columns 3 and 7 exclude women still enrolled in school during the last quarter observed, and columns 4 and 8 observations between four quarters before entry and four quarters after entry (eliminating quarters in the "Ashenfelter dip"). All dollar amounts adjusted for inflation (2010$).

Table 4: Robustness of Estimated Impacts to Alternative Specifications

	Dep. variable = quarterly earnings			Dep. variable = Pr(employed)		
	(1)	(2)	(3)	(4)	(5)	(6)
Any enrollment	-181			-0.009		
	(50)**			(0.009)		
No degree						
x **1**[1-15 credits earned]		-189			-0.006	
		(54)**			(0.010)	
x **1**[16-30 credits earned]		-205			-0.012	
		(77)**			(0.015)	
x **1**[31-45 credits earned]		-214			-0.029	
		(113)+			(0.019)	
x **1**[46-60 credits earned]		-19			0.0004	
		(135)			(0.024)	
x **1**[>61 credits earned]		-37			-0.012	
		(87)			(0.016)	
x Credits earned	0.88		-0.21	-0.00001		-0.00007
	(0.68)		(0.63)	(0.0001)		(0.0001)
Degree:						
Short-term certificate	560	388	504	0.126	0.118	0.119
	(139)**	(133)**	(132)**	(0.026)**	(0.025)**	(0.026)**
Certificate	810	660	591	0.125	0.117	0.123
	(225)**	(223)**	(411)**	(0.035)**	(0.034)**	(0.033)**
AAS	2275	2151	1994	0.214	0.207	0.237
	(298)**	(294)**	(283)**	(0.039)**	(0.039)**	(0.040)**
AA/AGS	567	408	369	0.155	0.147	0.093
	(237)*	(234)+	(222)+	(0.044)**	(0.044)**	(0.041)**
Bachelor's degree	1569	1430	1653	0.148	0.141	0.173
	(301)**	(300)**	(311)**	(0.044)**	(0.044)**	(0.045)**
Observations	857,124	857,124	857,124	857,124	857,124	857,124
Test of equality (*p*-value; reject if <0.1):						
30 credits = short-term certificate	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
AAS = AA/AGS	<0.001	<0.001	<0.001	0.312	0.324	0.011
All credentials	<0.001	<0.001	<0.001	0.377	0.391	0.041
Discrete enrollment effect	X			X		
Discrete categories of credits earned		X			X	
Highest degree only			X			X

Source: CDHS program data, CDLE quarterly earnings records, and CDHE enrollment files. *Note*s: Robust standard errors clustered by individual in parentheses; ** p<0.01, * p<0.05, + p<0.1. Each column denotes a separate regression. All regressions include individual fixed effects and linear trends. See Table 2 notes for description of additional control variables. Columns 1 and 4 specifications include an indicator for any college attendance. Columns 2 and 5 specifications replace the continuous measure of credits earned with discrete categories of credits earned (1-15, 16-30, 31-45, 46-60, and 61 or more). Columns 3 and 6 specifications only include indicators for the highest degree earned (where bachelor's degrees > associate of applied science degrees > associate of arts/general studies degrees > certificates > short-term certificates). All dollar amounts adjusted for inflation (2010$).

Table 5: Heterogeneity in the Impact of Community College Attendance by Quarters Since College Exit

	(1) Earnings	(2) Pr(employed)
1/quarters since exit	-78	0.029
	(46)+	(0.009)**
Degree:		
None x credits earned	-0.23	-0.0001
	(0.75)	(0.0001)
x 1/quarters since exit	0.80	0.00003
	(1.07)	(0.0002)
Short-term Certificate	444	0.113
	(136)**	(0.026)**
x 1/quarters since exit	-49	-0.0001
	(115)	(0.026)
Certificate	629	0.118
	(223)**	(0.035)**
x 1/quarters since exit	209	-0.015
	(197)	(0.035)
Associate of Applied Science	2037	0.200
	(314)**	(0.041)**
x 1/quarters since exit	471	0.018
	(277)+	(0.034)
Associate of Arts/GS	434	0.161
	(238)+	(0.044)**
x 1/quarters since exit	61	-0.080
	(236)	(0.038)*
Observations	857,124	857,124

Source: CDHS program data, CDLE quarterly earnings records, and CDHE enrollment files. *Note*s: Robust standard errors clustered by individual in parentheses; ** p<0.01, * p<0.05, + p<0.1. Each column denotes a separate regression. All regressions include individual fixed effects and linear trends, an indicator for bachelor's degree receipt, and an interaction between bachelor's degree receipt and the reciprocal of the number of quarters since leaving college. See Table 2 notes for description of additional control variables. All dollar amounts adjusted for inflation (2010$).

Table 6: Heterogeneity in the Impact of Credits and Degrees on Labor Market Outcomes by Program

	Dep. var. = quarterly earnings		Dep. var. = Pr(employed)	
	(1)	(2)	(3)	(4)
Credits earned, no credential				
x Health/math/science	-1.69	5.82	-0.0002	0.0002
	(2.06)	(1.98)**	(0.0004)	(0.0003)
x Other program	-0.83	0.02	-0.00004	0.0002
	(0.99)	(0.87)	(0.0002)	(0.0001)
Test of equality (p-value)	*0.733*	*0.013*	*0.817*	*0.777*
Short-term certificate				
x Health/math/science	515	--	0.115	--
	(159)**		(0.032)**	
x Other program	330	--	0.079	--
	(208)		(0.042)+	
Test of equality (p-value)	*0.504*		*0.506*	
Certificate				
x Health/math/science	1120	--	0.153	--
	(426)**		(0.048)**	
x Other program	263	--	0.113	--
	(195)		(0.046)*	
Test of equality (p-value)	*0.072*		*0.545*	
Associate of applied science				
x Health/math/science	3604	3192	0.235	0.169
	(482)**	(469)**	(0.055)**	(0.051)**
x Other program	707	680	0.204	0.193
	(295)*	(301)*	(0.062)**	(0.064)**
Test of equality (p-value)	*<0.001*	*<0.001*	*0.709*	*0.779*
Associate of arts/GS	440	433	0.160	0.157
	(236)	(234)+	(0.043)**	(0.043)**
Observations	857,124	857,124	857,124	857,124

Source: CDHS program data, CDLE quarterly earnings records, and CDHE enrollment and degree files. *Note*s: Robust standard errors clustered by individual in parentheses; ** p<0.01, * p<0.05, + p<0.1. Each column denotes a separate regression. All regressions include individual fixed effects and linear trends and an indicator for bachelor's degree receipt. See Table 2 notes for description of additional control variables. Columns 2 and 4 assume certificates are unobservable. All dollar amounts adjusted for inflation (2010$).

Table 7: Heterogeneity in the Impact of Credentials on Labor Market Outcomes by Program and Additional Credits Earned

	(1) Dep. Variable = quarterly earnings			(2) Dep. variable = Pr(employed)		
Field of study:	*Health/math/ science*	*Other*	*Test of eq. (p-value)*	*Health/math/ science*	*Other*	*Test of eq. (p-value)*
No credential						
x Total credits earned	-1.13	-0.30	*0.739*	-0.0001	-0.00001	*0.820*
	(2.06)	(0.99)		(0.0004)	(0.0002)	
Short-term certificate	512	341	*0.536*	0.114	0.077	*0.487*
	(159)**	(207)		(0.032)**	(0.042)+	
x (Total credits - 15)	2.51	-1.21	*0.482*	0.0004	0.0006	*0.881*
	(4.23)	(3.17)		(0.001)	(0.0008)	
Certificate	1160	333	*0.068*	0.155	0.118	*0.571*
	(399)**	(194)		(0.048)**	(0.046)*	
x (Total credits - 30)	19.18	-2.37	*0.003*	0.0001	-0.0001	*0.829*
	(7.09)**	(1.52)		(0.0009)	(0.0003)	
Associate of applied science	2801	684	*<0.001*	0.226	0.190	*0.669*
	(434)**	(279)*		(0.057)**	(0.062)**	
x (Total credits - 60)	29.14	3.37	*0.007*	0.0004	0.0007	*0.619*
	(8.52)**	(2.91)		(0.0006)	(0.0004)	
Associate of arts/GS	--	446	--	--	0.159	--
	--	(230)+		--	(0.043)**	
x (Total credits - 60)	--	2.20	--	--	0.0001	--
	--	(1.78)			(0.0002)	
Observations		857,124			857,124	

Source: CDHS program data, CDLE quarterly earnings records, and CDHE enrollment and degree files. *Notes*: Robust standard errors clustered by individual in parentheses; ** p<0.01, * p<0.05, + p<0.1. Each column denotes a separate regression. All regressions include individual fixed effects and linear trends, an indicator for bachelor's degree receipt, and bachelor's degree receipt interacted with the number of credits earned beyond the minimum required for the degree (120). See Table 2 notes for description of additional control variables. All dollar amounts adjusted for inflation (2010$).

Table 8: Private Returns to Community College Credits and Credentials over the Medium-Run

	No credential	Short-term certificate	Certificate	Associate of applied science	Associate of arts/GS
Quarters of enrollment	7	4	9	13	11
Total costs					
Foregone earnings	$3,780	$2,160	$4,860	$7,020	$5,940
Tuition and fees	$25,543	$13,084	$33,102	$48,503	$43,593
Total resources while in school					
Cash assistance	$3,171	$2,528	$4,743	$7,202	$5,258
Financial aid	$15,365	$7,480	$26,289	$40,287	$35,453
Resources - costs	-$10,787	-$5,236	-$6,930	-$8,034	-$8,822
PDV of net return by years since initial enrollment					
1 year	-$6,164	-$5,236	-$3,080	-$2,472	-$3,208
2 years	-$15,559	-$4,352	-$6,070	-$4,872	-$6,323
5 years	-$18,206	-$1,274	-$3,321	$2,379	-$7,435
10 years	-$22,006	$4,330	$1,411	$27,420	-$8,118
Years to break even	N/A	7	9	5	20

Source: CDHS program data, CDLE quarterly earnings records, and CDHE enrollment, degree, and financial aid files. *Notes*: Foregone earnings calculated using the estimated impact of enrollment on quarterly earnings displayed in Table 2 ($530 lost per quarter). Tuition and fees calculated using the total cost of attendance over all quarters enrolled multiplied by $\frac{2}{3}$ (to take into account the fact cost of attendance includes tuition, fees, and living expenses). Total cash assistance and financial aid (grants and loans) calculated using the total amount of aid received in quarters of enrollment. Net returns are equal to earnings gains less net costs and loan payments at t years from school exit using a 3 percent discount rate. See Section 6 for additional details.